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Iran And Qatar, Gas Production in South Pars

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Abstract

South Pars gas field is the world's largest gas field lying on the territorial border between Iran and the State of Qatar. It is located 100 kilometers to the southern coast of Iran. This field is known as North Dome in Qatar and it was explored during the drilling of Dome-1 in 1350 by Shell. The total area of field is 9.700 km2, and the section which is owned by Qatar is 6000 km2. (About 62%).North Dome field in Qatar is drawn from Iran's border to the coast of Qatar. In Iran in 1369 exploratory drilling of the first well in this field and the results of the seismic tests has confirmed the existence of a major natural gas field. This gas field covers an area of 9700 square kilometers, of which 3700 square kilometers belongs to Iran (38 percent). The two countries have worked hard to extract from this giant gas field. Due to sanctions and lack of investment, Iran is behind Qatar. But by starting post-sanction era and lifting sanctions great steps have been taken. This article is an analogy between the two countries in this field pays great condition. The current article makes a comparison of the two countries in this big field. Methodology of this article is analysis and descriptive.

Qatar gas reserves in the world

Unlike oil reserves of Qatar that is not a significant amount, gas reserves of this country has a key role in international markets. In fact, Qatar has the third largest gas reserves in the world after Russia and Iran, with 25,100 billion cubic meters of proven gas reserves, or around 13.4% of the world's total. Almost all gas reserves of Qatar is located in the North Dome field.

Table 1: Qatar's position among the world's gas reserves holders

Rank on the world	Country name	Reserves	The share of total world reserves (percent)
1	Iran	33.6	18
2	Russia	32.9	17.6
3	Qatar	25.1	13.4
4	Turkmenistan	17.5	9.3
5	USA	8.5	4.5
6	Saudi Arabia	8.2	4.4

Qatar is also one of the biggest exporters of LNG in the world. The country's main LNG export is to Asian markets and European countries in recent years.

North Dome field in Qatar

The world's largest gas field, South Pars is located 100 km to the south of the Iranian coast in the Persian Gulf on the common border between Iran and Qatar. The field which is known as North Dome was discovered in 1971 with the completion of Shell's Dome-1 well. South Pars covers an area of 9,700 square kilometers; 6,000 square kilometers are situated in Qatar's territorial waters (About 62 percent). North Dome gas field in Qatar is drawn from the common border of Iran and Qatar to the coast of that country. The current development of the field has been done where the gas reserves are estimated at 25.5 tcm. In this part of the field, all four reservoir layers K1 to K4 contain gas. [1]

According to the International Energy Agency (IEA), the field holds an estimated 1,800 trillion cubic feet (51 trillion cubic metres) of in-situ natural gas and some 50 billion barrels (7.9 billion cubic metres) of natural gas condensates.[2]

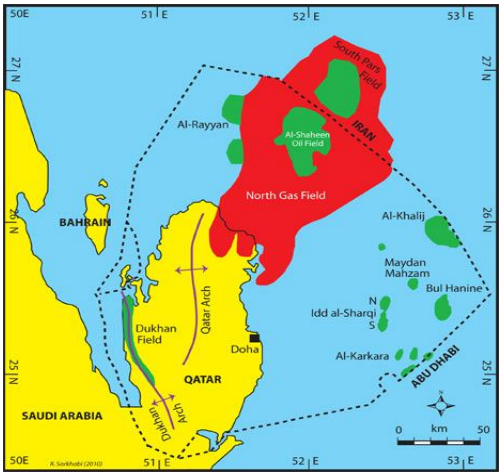

Figure 1: Location map of North Dome field and the other neighboring fields

Phases and blocks of North Dome field

The average production of each well in Qatari section is about 60 to 70 million cubic feet per day, and with this amount of production, there is no need to use the compressor up to 25 years. Qatar is worried that daily production of Iran is more than 100 million cubic feet from common field and believes that it is not a protective production. The following figure shows the Phases and blocks of North Dome. [3]

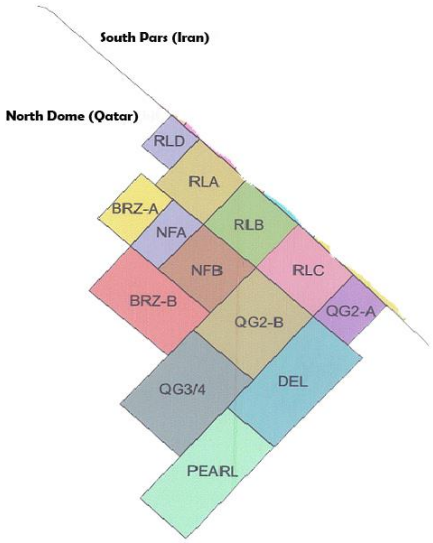

Figure 2: Phases and blocks of North Dome field (Qatar)

The production of Qatar's North Dome field

Qatar used the potential of international companies, particularly US companies to plan to speed up and boost production from North Dome gas field reserves. Production from North Dome field has started in 1996 and the develop plan of the field has completed in 2014. (during 18 years) North Dome gas field production has increased from 24.5 million cubic meters per day in 1996 to 680 million cubic meters per

day in 2014. In fact, Qatar annually added the average amount of 36.5 million cubic meters per day to its gas production from last 18 years. [4]

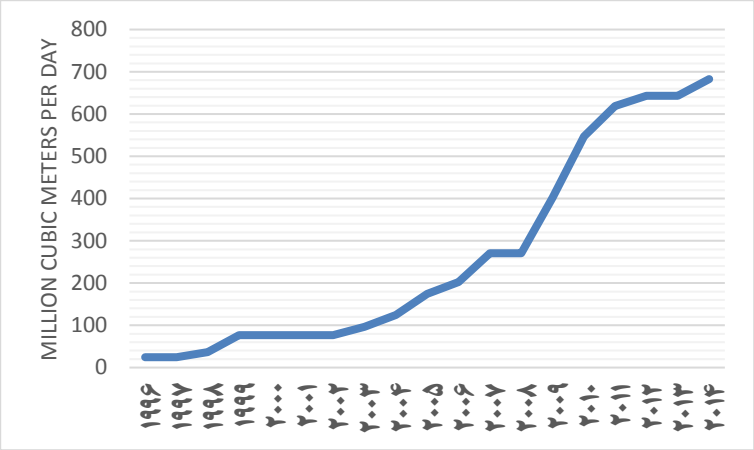

Figure 3: Qatar's North Dome Field Production from the Beginning until 2014

From the beginning until 2014, Qatar extracted some 1824 billion cubic meters of gas from Dome gas field. (Cumulative production), which is 2.5 times more than Iran's production from South Pars from the beginning of development to the end of 2014.

Qatar's North Dome Field projects

All production facilities of North Dome (South Pars) are located in the Ras Laffan Industrial Port. It lies 80 kilometers off the North-East Coast of Doha, covering 106 square kilometers. Run by a management team appointed by Qatar Petroleum This city has a strategic location and is close to the ferry transportation.

Facilities and complexes produced in this area and their capacity are:

- Two giant LNG plant with a capacity of 77 million tons per year.
- Two production plants with a capacity of 174000 barrels a day named Pearl GTL and GTL ORYX GTL.

Three gas refineries with a capacity of 4,000 million cubic feet per day, Gulf Gas 1 and 2 and dolphins, refine gas for delivery to domestic needs of Qatar and exporting gas by pipeline to neighboring countries. In 2014, another gas refinery with capacity of 1400 million cubic feet per day will be enter to production cycle. (Barzan)

1. The production of Ras Laffan condensate refinery with a capacity of 146 barrels per day, which is scheduled to double its capacity during the second half of 2016 (Phase 2) are naphtha, jet fuel, diesel and LPG. [5]
2. Ras Laffan Olefins Company (RLOC) is a petrochemical complex with a production capacity of 1.3 million tons per year of ethylene, which has been set up in 2010. In the area of Ras Laffan, there are three plants with a capacity of 4537 MW, which are the sources of power of utilizations for production and operation. [6]

It should be noted that total investments for this amount of production and operation of units, around 105 billion dollars is estimated and 55.1 billion dollars is spent (with a capacity of 77 million tons per year) in the production of LNG. (52.6%) 20 billion dollars in the GTL production (with a capacity of 174 barrels per day), 22.1 billion dollars in gas refineries for refining gas for domestic consumption and exporting through pipeline (with capacity of 5,400 million cubic feet per day), 7 billion dollars in gas condensate refineries (with a refining capacity of 292 barrels per day) and 615 million dollars in the production of helium (with a capacity of 1,900 million cubic feet per year) are invested. The Exxon Mobil

has invested about US $ 20 billion over the past two decades in various North Dome Field gas Development projects.

South Pars field, Islamic Republic of Iran

South Pars gas field is the world's largest gas field lying on the territorial border between Iran and the State of Qatar in the Persian Gulf and it is located 100 km to the south of the Iranian coast. This field is known as North Dome in Qatar and it was explored during the drilling of Dome-1 in 1350 by Shell. In Iran in 1369 exploratory drilling of the first well in this field and the results of the seismic surveys has confirmed the existence of a major natural gas field. This gas field covers an area of 9700 square kilometers, of which 3700 square kilometers belongs to Iran (38 percent). According to the latest estimates, about 8 percent of total world gas reserves and approximately half of the gas reserves of Iran are in the South Pars field. The field contains 13 trillion cubic meters of gas and 26 billion barrels of recoverable reserves of gas condensate. Development of field in different phases according to the five-year plan for Iran's economic, social and cultural development and to supply the growing demand for natural gas for domestic consumption, and in order to preserve the tanks, injection in oil fields and gas exporting are top on the agenda of the National Iranian oil company. [7] Kangan and Dalan formations contain gas in the South Pars gas field and have four main layers K1, K2, K3, K4. Four main layers of the reservoir each divided into sub-layers that feature different tank and reservoir properties. One of the most important features of South Pars is the diagonal position of water and gas levels (West-west south to east south-east). Because of its performance, the eastern part of the field contains deeper level of gas and water and therefore the amount of gas reserves in Iran (North-East) has increased. It should be noted that the in-situ gas and condensate reserves in the layer k4 is more than the other layers. Based on reservoir studies and the results of exploratory wells, it is estimated to produce 28 billion cubic feet daily from 24 phases of this field. For the processing and supplying of natural gas and domestic consumption, except the utilities and independent platforms in each phase, common infrastructure, including office buildings and facilities, airports, town, fresh water supply, operational base, facilities, desalination of sea water, telecom facilities, port logistics and road has been constructed beside gas refineries in 16 phases of Assaluyeh (Pars special economic energy Zone).

History of blocks in South Pars and North Dome

South Pars oil and gas field is the world's first field in which 3-phases of water, gas and condensate with a large amount are moved along more than 100 kilometers. And this is due to the country's policy to produce and transport of gas from this field. Meanwhile, the Qatari side is transported from the platform to the FSU for exporting condensate directly in many phases and after separating gas condensate in the platform is transferred to the onshore facilities. In Iran, the French energy company Total widely studied how to design 3-phase flow to the coast in the South Pars field scale that resulted in developing three phase flow software such as OLGA. The results of these studies led to transferring 1 million cubic feet per day through 32-inch pipeline according to the temperature and pressure conditions of the region. So, the phases and platforms of the South Pars have been developed to produce1 million cubic feet per day. The reason for choosing 1 million cubic feet production per day in South pars is not reservoir or processing and economic issues, but third-phase flow. According to the well models designed by Shell for the phases 2 and 3, and the situation of each phase in the reservoir, the area that has the potential to produce 1 million cubic feet per day is selected as a phase. It should be noted that in the total's design, there was no production from layers K1 and this layer was recently perforated in phases 2 and 3. Also after defining ten phases, it was found that some parts of the reservoir will remain intact according to the existing model of wells. So, some new phases were defined in the previous 10 phases. For example, phases 19, 20 and 21 were defined in phases 1, 4, and 5. [8] In order to have the maximum intended production of each phase without using any CMO compressor during 25 years, the size of developed Blocks in Qatar is in such a way that on average a block with the potential of 4 billion cubic feet is allocated for each one billion cubic feet production per day. Average production of each well in Qatar section is about 60-70 million cubic feet per day, with this amount of production there will be no need to use the compressor for 25 years. The following figure shows the defined phases and blocks of South Pars and North Dome. [9] All contracts of rigs and

related materials needed for each project are purchased through a tender in Qatar and is separated and Qatar Petroleum does not purchase the project items directly, especially items such as scarce items like CRA, Xmass Tree and etc. In the South Pars field (Iran section) a total of 406 wells for production from all phases are predicted. Of this number to December 1392, 172 wells have been drilled and completed (42.3%) and drilling of 117 wells will be finished in future. (28.8%) and drilling operations of 117 wells is not started. (28.8 percent) In the first priority phases (15, 16, 17 and 18. 12), 111 wells should be drilled to December 1392, and 57 wells have been completed (51.3%) and 38 wells will be finished soon. (34.2 percent) For developing the second priority phases, 157 wells should be drilled and until December 1392, 5 wells are completed (3.2%) and 75 wells will be finished in future. (47.7 percent)

Table 2: Drilling in South Pars phases until 1392

South Pars Phases	The number of wells				Excavation area (Meter)	Area plan (Meter)
	Completed	Drilling	Not started	Total Well		
Developed Phases (1to 10)	110	0	0	110	439748	439748
First priority phases	57	38	16	111	320865	461269
12	21	16	8	45	134838	189869
15 & 16	16	6	0	22	83819	90542
17 & 18	20	16	8	44	102208	180858
Second priority phases	5	75	77	157	119561	654211
13	0	14	24	38	24860	155446
14	0	14	30	44	30214	187476
19	5	5	5	15	27801	57450
20 & 21	0	22	0	22	12856	91941
22, 23 & 24	0	20	18	38	23830	161898
11	0	0	24	24	0	103487
Total South Pars	172	117	117	406	891258	1674853

The number of active drilling rigs in Iran's South Pars gas field until December 1392 was 20 rigs, and 11 rigs are active in developing boundary phases (Phases 12, 15-16, 17-18) and 8 rigs in developing non-boundary phases and one rig is also active for maintenance activities. The activities of rigs in different phases are as follows.

History of South Pars development

The first contract to develop the South Pars gas field phases was signed at the presidency of Mr. Khatami in Mehr 1376. Petropars has signed the second contract to develop South Pars gas field phases in Bahman 1376. The third contract with Statoil and TIJD to develop the South Pars phases 6, 7 and 8 was signed in Tir 1379. The next contract with Eni, Petropars and Nicoo to develop the South Pars phases 4 and 5 was signed in Mordad 1379. In Shahrivar 1381 contract with LG, O1 and Iranian Offshore Engineering and Construction Company (IOEC) to develop phases 9 and 10 was signed. Production from these phases was started in 1389 by 4.7 million cubic meters per day. Following the development plans of the South Pars gas field, oil layer development contract with Petro Iran and Services Iran (MC) was signed in Isfand 1383 to extract 35 thousand barrels of oil per day in its first phase and 54 thousand barrels of oil per day in the second phase. The contract for development of phases 17 and 18 was signed with Industrial Development and Renovation Organization (IDRO), O1, and National Iranian Oil Engineering and Construction Company) NIOEC) in Khordad 1384. The last contract for the development of South Pars at the presidency of Mr. Khatami, was signed with Petro Pars to develop Phase 12 in 1384. The first contract to develop the South Pars phases in the presidency of Mr. Ahmadinejad was signed in 1385. This contract was signed with Khatam-al Anbiya Construction Headquarters, Iran Shipbuilding & Offshore Industries Complex Co (ISOICO), Iranian Offshore Engineering and Construction Company (IOEC) and Saff Offshore Industries Co. to develop phases 15 and 16. The contract to develop the five projects of South Pars consists of phases 13, 14, 19, 20, 21, 22, 23 and 24 was signed with the local contractors and in the presence of the President

in 1389. According to decision of the workgroup that is consist of the representatives of the President in petroleum affairs, the operation of these phases started in Khordad 1389. [10]

The production of natural gas in the South Pars field

The South Pars field production process is shown in Table 4. As it can be seen, since 1381, gas production started from the field to produce 33 million cubic metres per day and in 1392, gas production reached 262 million cubic meters per Since the beginning of the exploitation of South Pars gas field by the end of 1392, Iran has produced 647.5 billion cubic meters of gas from this field. (Cumulative production)

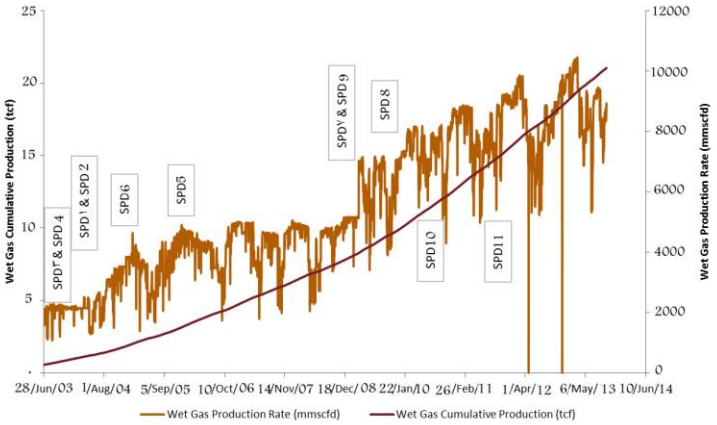

Figure 4: South Pars gas field production rates and cumulative production (to September 1392)

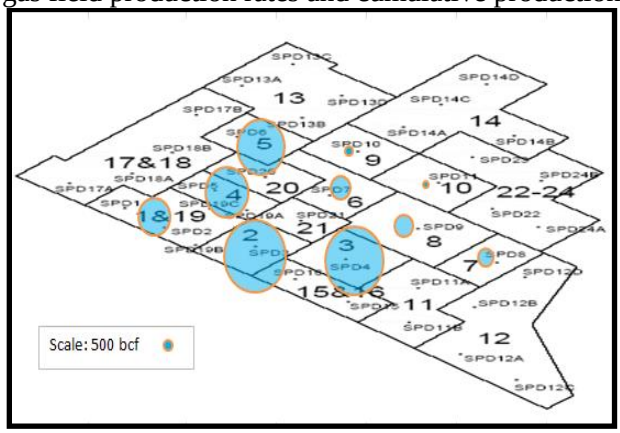

Figure5: Cumulative production of platforms since the beginning of the second half of 1392

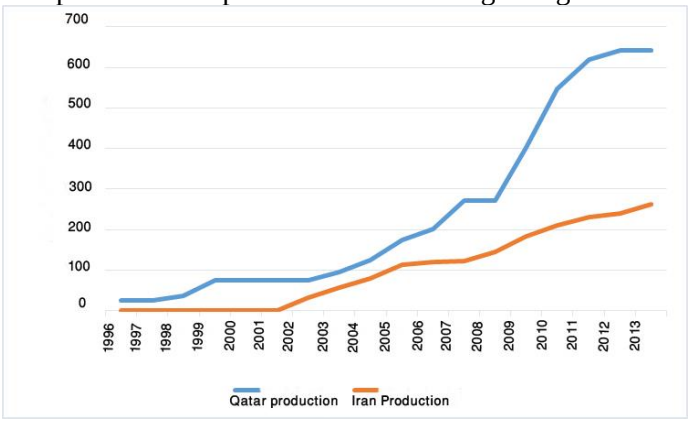

Figure6: Comparison of daily production in the South Pars field of Iran and north Dome of Qatar

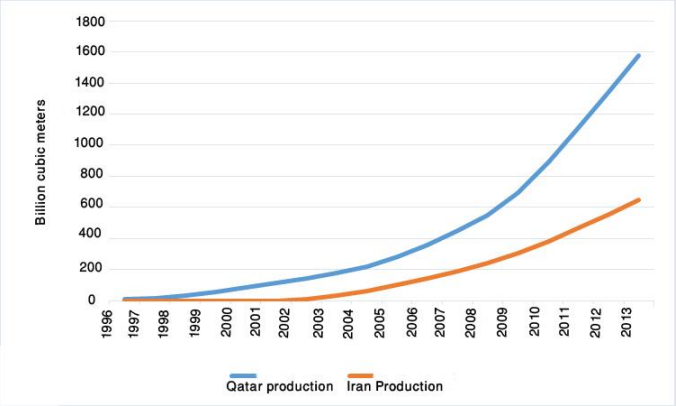

Figure 7: Comparison of daily cumulative production in South Pars and North Dome (Iran and Qatar)

It should be noted that annual production plans of South Pars gas field is defined and approved by Pars Oil and Gas Company and National Iranian Oil Company after reservoir studies and approval the maximum level of gas production from the joint reservoir by management of NIOC consolidated planning. But because of the delay in setting up new projects every year in winter and high gas consumption in country, according to the request of the Winter Fuel Committee to recover the needs of network, production from South Pars phases increased and became more than the safe capacity of platforms and the potential of protective production. .It should be noted that this action not only reduce the ultimate recovery factor of the South Pars joint reservoir and leaving a considerable amount of valuable condensate gas in the reservoir, but also causes severe and rapid decline in gas production from wells in this field in coming years.

Estimated future production of South Pars gas field

According to the revised schedule of the National Iranian Oil Company that it is more consistent with reality, South Pars gas field production is predicted during the next years as following. However, because the contract of phase 11 has not been finalized, no production for this phase is predicted in the revised schedule. After signing a contract for developing phase 11, the production of this phase will be added to the schedule.

Table3: South Pars gas production Forecast in 2017

Phase	1392	1393	1394	2016	2017
Phase 1	25.18	25	25	25	25
Phases 2 & 3	56.88	55	55	55	55
Phases 4 & 5	60.07	60	60	60	60
Phases 6, 7 & 8	67.89	70	70	70	70
Phases 9 & 10	52.60	50	50	50	50
Phase 11	0	0	0	0	0
Phase 12		50	75	75	75
Phase 13	0	0	12.5	37.5	50
Phase 14	0	0	0	25	50
Phases 15 & 16	0	50	50	50	50
Phases 17 & 18	0	50	50	50	50
Phase 19	0	0	12.5	50	50
Phases 20 & 21	0	0	0	50	50
Phases 22, 23 & 24	0	0	12.5	50	50
Total South Pars phases	262.6	415	477.5	652.5	690

Source: planning Deputy of the Ministry of Oil

As can be seen in the case of performing the above schedule, gas production in South Pars field in 2017 will be 2.6 times more than the production in 1392 and from 262 million cubic meters per day in 1392 will reach to 690 million cubic meters per day in 2017. Hope to sign the contract of phase 11 of South Pars, and increase the total production of this field in 1397 to more than 750 million cubic meters per day.

It is expected to perform the development plans of South Pars phases, in the year 1397 (2017) to leave Qatar behind in South Pars joint field.

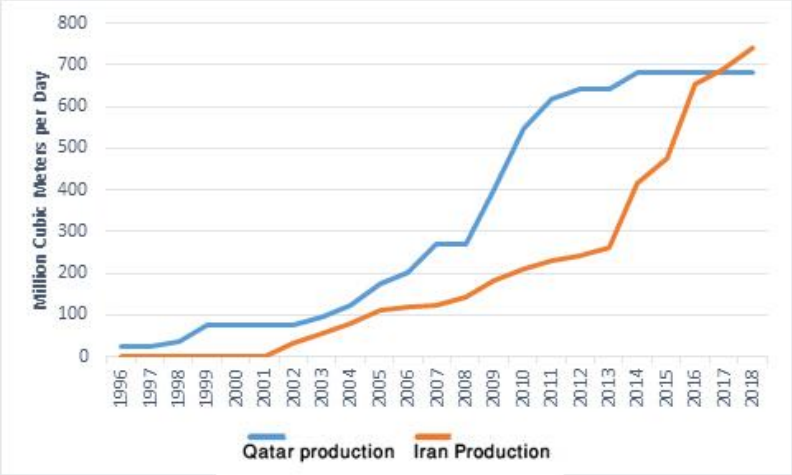

Figure8: Comparison of South Pars and North Dome gas production in 2018

The investment required for the development of South Pars gas field

The total investment required for the development of all phases of the South Pars field including field development and construction of refinery units for processing is estimated about 72 billion dollars. 19 billion dollar is needed for the development of phases 1 to 10, which are operational now. 18.3 billion dollar is related to the first development priority phases: 12-15, 16, 17 and18. 29.5 billion dollars is needed for the second development priority phases (Phases 13-14-19-20, 21, 22, 23 and 24). No contract is signed for the development of phase 11 but 5 billion dollars was considered to invest for the development of this phase in previous contracts. From the total investment predicted for the development of South Pars gas field phases until the third month of 1392 about 48 billion dollars investment has been invested (66 percent). About 18 billion dollars of this amount has been invested in phases 1 to 10. In the first and second priority development phases has been invested about 30 billion dollars up to 1392. . In fact, from 1376 to 1392 annually about 3 billion dollars has been invested in South Pars field in average. This amount of investment is little according to the priority and importance of the field in development and economic growth of the country. It is noteworthy that the remaining funding required to completing phases 12 to 24 is about 18 billion dollars and by adding phase 11 it will become about 23 billion dollars. Obviously, the above amounts will change by changing in the amount of investment in projects. Therefore, it is clear from the above calculations that 48 billion investments in the South Pars field up to 1392 resulted in more than 220 billion dollars revenue for the country directly. This means that investment of each dollar in South Pars will generate 4.6 dollars of revenues.

Reserves and production potential of Pars Special Zone oil and gas fields

The details Storage and development status of hydrocarbon resources in the fields of North Pars, Golshan, Ferdowsi, and Farzad A & B, which are located in the Pars Special Economic Zone are described below.

North Pars gas field

North Pars gas field is one of the biggest independent gas fields of the world. This field which was discovered in 1967 is located some 120 kilometers south east of Bushehr province in water depths of 2 to 30 meters in the Persian Gulf. This field is located 4000 deep under water and this field sprawls on an area measuring 21 kilometers long and 19 kilometers wide. The dome-shaped field has a slope less than 20 degrees. This field is located approximately 58 kilometers far from the South Pars gas field. After the exploration of the giant South Pars field which is shared by Qatar's North Dome, South Pars oil field

development contracts become the top priority programs of the Ministry of Petroleum. Thus, according to the importance of the development of South Pars to production gas, development of North Pars gas field to produce gas is already pending.

At present, final studies for development of this field - 4 phases- equivalent to 101 million cubic meters is under implementation. The whole recovered gas from this field will be used for producing 20 Million ton of LNG.

Golshan gas field

Golshan gas field is located at approximately 180 km south east of Bushehr, 65 km offshore the Persian Gulf on the western edge of the ridge Qatar-Fars. This field has been discovered by Lavan Oil Company (LAPCO) during the exploration and seismic field operations in 1965. Main data of Golshan gas field is related to wells 1 and 2 in 1966 and earlier. The field contains one oil layer but the gas layer is deeper than oil layers. Three exploration wells have been drilled in this field.

Ferdowsi Gas Field

Ferdowsi Gas Field is located in the middle of the Persian Gulf, at approximately 190 kilometers southeast of Bushehr, 85 kilometers offshore the Persian Gulf and 30 km West the Golshan gas field. This gas field has been discovered by former oil company, IROPCO, in 1965 during seismic tests and IROPCO evaluated Ferdowsi Gas Field through drilling two wells.

Farzad A & Farzad B gas fields (Farsi)

Farzad-A Gas Field is located in Farsi Block on Iran-Saudi Arabia border line. To the discovery of oil, one well has been drilled on the field before the Islamic revolution. In 1390 exploration management drilled Farzad 2 well to a depth of 4340. After reaching the depth of 4340, they decided to increase the well's depth up to the Faraghan layer. Farzad-A Gas Field is located in Farsi Block on Iran-Saudi Arabia border line. Farzad B field block reserves are sour gas that contains 0.3% hydrogen sulfide. About 80 percent of this field is located in Iranian waters. So far, two wells have been drilled in this undeveloped field. The Arabic section of Farzad A Field is called Arabiyah. This field is located 200 kilometers northeast of Dhahran. The Production of this field is reached to 62.1 million cubic feet per day of natural gas from the depth of 3872 meters. On 24 February 2010 Saudi Aramco announced that 12.1 million cubic feet is produced at Jalamid3 well from the depth of 2985 meters. The Arabic section of Farzad B Field is called Hasbah. The field is located 200 kilometers northeast of Dhahran. The Production of this field is reached to 62.1million cubic feet per day of natural gas from the depth of 3872 meters. On 24 February 2010 Saudi Aramco announced that 12.1 million cubic feet is produced at Jalamid3 well from the depth of 2985 meters.

Oil and gas reserves and production forecast at South Pars Special Zone

Situ and recoverable gas reserves of gas fields located in Pars Special Economic Zone are as follows.

Table 4: Recoverable Reserves of Fields at Pars Special Economic Zone

Field	Trillion cubic feet	Bcm
North Pars	46.96	1330
Golshan	23.9	677
Ferdowsi	3.8	108
Farzad A & B	10	283.3
Total	84.66	2398

Comparison of the two countries

Qatar started producing gas from the North Dome in 1991, but Iran started producing gas from the South Pars in 2001. So that Iran was 10 years behind in getting its share from the South Pars. Qatar took some 210 billion cubic meters of gas and its revenue was about 60 billion dollars. Qatar defined several projects in North Dome and now has 16 active phases and produce 650 million cubic meters per day from the Qatari section of joint South Pars gas field and Iran take 430 million cubic meters per day from Iranian section of South Pars gas field. In other words, Qatar produces gas 1.5 times more than Iran from joint field. According to one of the officials of the Ministry of Petroleum, Qatar extracted 2.5 times more than Iran from South Pars s in 1392. 24 Phases are defined for development of South Pars in Iran. Now phases 1 to 10 are fully operational. Phase 11 of South Pars is an undeveloped phase of this joint field but Qatar is

taking gas from a section near this phase as fast as possible. Phases 12, 15 and 16 are operational and other phases are in progress. Development of phases 12, 15 and 16 was finished at the time of the 11th government. Phases 17 and 18: The contract of these two-phases was signed in 1385. After 7.5 years these 40 percent of onshore, 65 percent of the drilling, 100 percent of pipeline and 80 percent of construction of platforms were developed in these two phases and overall progress was 60%. At best condition, it is expected to complete these two phases in 2016-2017. The Contract of phases 13, 14 and 19 (each one equals two phases), 20, 21, 22, 23 and 24 was signed on 25 Khordad 1389 with a group of domestic companies, and announced that these project will be one month before the end of the government of Mr. Ahmadinejad, (25 Ordibehesht 1392) but so far these phases are under development.. However 37 months after signing the contract, the actual progress of these projects was about 30-40 percent. While Iran has invested nearly 60 billion dollars in South Pars since 2001, Qatar has invested about 420 billion dollars in North Dome field since 1991.

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